Chapter 2

THE CALOOSAHATCHEE WATERSHED

PLANNING AREA

The planning area for the Caloosahatchee Water Management Plan (CWMP) includes the entire watershed for the river, from Lake Okeechobee to the mouth of the Caloosahatchee River Estuary.

The CWMP Planning Area is shown on Figure 2.1.

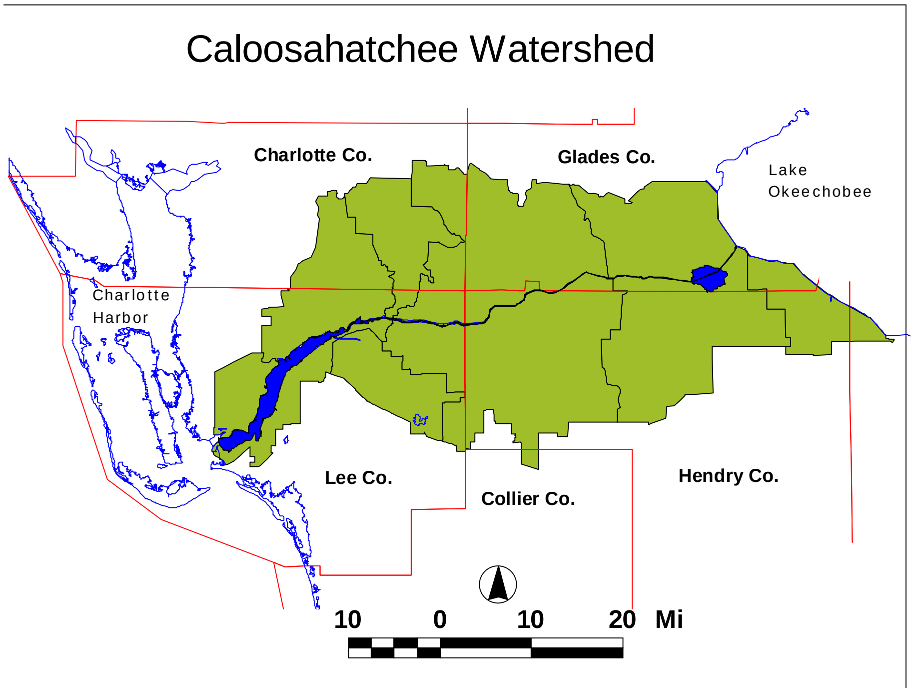


Figure 2.1 Caloosahatchee Water Management Plan Planning Area

The Caloosahatchee River (C-43), along with the St. Lucie Canal (C-44), is used primarily for water releases from the lake when lake levels exceed water stages of the U.S. Army Corps of Engineer's regulation schedule. In addition to regulatory discharges for flood protection, the Caloosahatchee River receives water deliveries from the lake to maintain water levels for navigation and water supply.

THE CALOOSAHATCHEE RIVER

The Caloosahatchee River was originally a shallow, meandering river with headwaters in the proximity of Lake Hicpochee. To accommodate navigation, flood control, and land reclamation needs, the freshwater portion of the river was reconfigured into a canal known as C-43. Many canals were constructed along the banks of the river in support of the many agricultural communities along the river. In addition, three lock-and-dam structures (S-77, S-78, and S-79) were added to control flow and stage height.

The final downstream structure (S-79) marks the beginning of the Caloosahatchee Estuary. Also called the W.P. Franklin Lock and Dam, this structure maintains specified water levels upstream, regulates freshwater discharge into the estuary, and acts as an impediment to saltwater intrusion to the river. The Moore Haven Lock (S-77), located on the southwest shore of the Lake Okeechobee, regulates lake waters. The Ortona Lock (S-78) aids in control of water levels on adjacent lands upstream and separates C-43 into eastern and western basins.

Today, the Caloosahatchee River extends 105 kilometers (km) from Lake Okeechobee to San Carlos Bay. The freshwater portion ranges from 50 to 130 meters (m) in width and 6 to 9 meters in depth. Many of the original bends remain as oxbows along both sides of the canal. The width of the estuarine portion is irregular, from 160 m in the upper portion to 2,500 m downstream at San Carlos Bay (Scarlatos 1988). The narrow section extends from Franklin Lock and Dam to Beautiful Island. This area has an average depth of 6 m and the area downstream of Beautiful Island has an average depth of 1.5-m (Scarlatos 1988). The pattern and period of flow of the Caloosahatchee River is highly variable based on demand and is often negative (from west to east), possibly from irrigation usage (Drew and Schomer 1984).

The freshwater systems of the Caloosahatchee River are divided into two distinct hydrologic units, East and West Basins. These basins include parts of Lee, Charlotte, Collier, Glades, and Hendry Counties. Tributary drainage in the East Basin is more intricate than in the West Basin. Irrigation is the most important water use in this area and is controlled by an extensive network of canals that recharge the water table during the dry season and drain potential floodwaters during the wet season. Land use in the West Basin is also largely agricultural. The Caloosahatchee River also serves as an important source of drinking water in the West Basin.

The Tidal Caloosahatchee Basin includes portions of Lee and Charlotte Counties. The estuary length between Franklin Lock and Shell point is 42 km and is bordered by Fort Myers on the south shore and Cape Coral on the north shore. Water discharges from the Caloosahatchee passes Shell Point and enters the Gulf of Mexico at San Carlos Bay. Because of the irregular, long, slender shape of the system, slight changes in wind, tide, runoff, or precipitation can have dramatic effects on several estuarine features such as flow, water depth, salinity, and turbidity, making characterization of the system difficult.

The hydrology of the Caloosahatchee watershed has been strongly affected by land and canal development during the past 100 years. In pre-development times, the Caloosahatchee River was a sinuous river extending from Beautiful Island to a waterfall at the west-end of Lake Flirt. A sawgrass marsh extended from Lake Flirt to Lake Okeechobee. The pre-development landscape had few tributaries east of LaBelle and Twelve-mile Slough connected the Okaloacoochee Slough to the Orange River (Fig. 2.2). The area east of LaBelle is very flat and there were few creeks to provide drainage. In the 1880s, the Disston canal was dug from Lake Flirt to Lake Okeechobee to provide a navigable channel for steamboats from Lake Kissimmee through Lake Okeechobee to the Gulf of Mexico (COE, 1957). The channel was enlarged to a 6-foot depth and 90-foot width during the period 1910 to 1930, and three locks were constructed along the canal in 1918 to improve navigation.

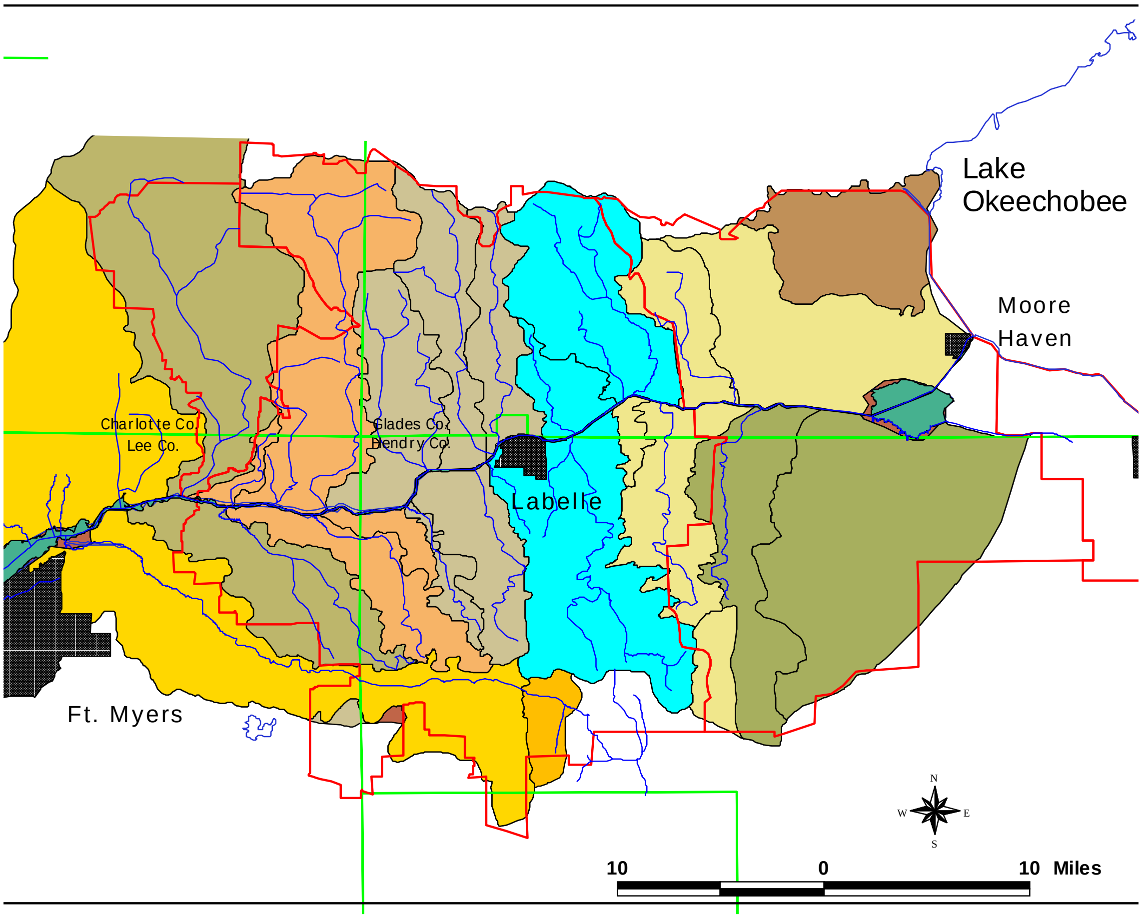


Figure 2.2. Pre-development Hydrology in the Caloosahatchee Watershed.

PHYSIOGRAPHY

The Caloosahatchee River watershed lies predominately within the Caloosahatchee River Valley, which rises less than fifteen feet in elevation through Lee, Hendry, and Glades Counties. The valley axis follows the river from Lake Okeechobee to San Carlos Bay. The basin also includes a portion of the Immokalee Rise, an elevated flat area of predominately sandy soils to the southwest of the river; the Gulf Coastal Lowlands, which parallels and borders the western coastal areas of the state; the Caloosahatchee Incline, a valley wall that slopes upward to the north end of the river; and the DeSoto Plain, a very flat terrace extending down from the Polk Uplands of the Central Florida Highlands (Drew and Schomer 1984).

GEOLOGY

Rock units ranging in age from Oligocene to recent are penetrated by production and monitor wells within the planning area. Formations and groups discussed in this report include the Suwannee Limestone, Hawthorn Group, Tamiami Formation, and undifferentiated terrace deposits including the Caloosahatchee Marl and Fort Thompson formation.

Oligocene Series. Rocks of Oligocene age in the planning area belong to the Suwannee Limestone. In Lee County the Suwannee Limestone is typically a yellow to pale orange, moderately indurated, very porous calcarenite interbedded with sandy phosphatic limestones and dolomites. The formation varies in thickness from 50 feet to more than 150 feet. The Suwannee Limestone is used for irrigation in Glades County.

Miocene Series. Rocks of Miocene age in the planning area belong to the Hawthorn Group. The Hawthorn Group is divided into lower carbonate and upper clastic sequences. The carbonate sequence is composed of poorly to moderately indurated phosphatic micrites and dolomites. The upper clastic sequence is composed primarily of greenish-gray phosphatic silts interbedded with coarse sand and sandstones. The base of the Hawthorn Group occurs at the contact between the Suwannee Limestone and the Lower Hawthorn/Tampa Limestone. The top of the Hawthorn Group in Lee County is identified by the first occurrence of a continuous greenish-gray dolosilt. In Hendry County the top of the Hawthorn Group occurs at a poorly consolidated sand or sandy silt beneath the biogenic limestones of the Tamiami Formation.

Pliocene Series. The Tamiami Formation in the planning area is characterized by a fosiliferous sandy limestone. In northern Hendry and southern Glades counties the formation is thin and difficult to distinguish from the younger biogenic limestones of the Fort Thompson Limestone and Calooshatchee Marl. The Tamiami Formation is thickest in southern Hendry County. It thins to the north and west, pinching out in Glades County.

Pleistocene - Recent Series. The rocks above the Tamiami Formation vary throughout the planning area, but two locally identifiable formations are of particular interest. The Caloosahatchee Marl, identified by Heilprin (1887) along the banks of the Caloosahatchee River, and the Fort Thompson Formation identified by Sellards (1919) along the banks of the Caloosahatchee River at Fort Thompson 2 miles east of LaBelle. The Caloosahatchee Marl is a discontinuous deposit of unconsolidated sand and sandy marl with abundant marine mollusk fossils.

The Fort Thompson Formation unconformably overlies the Caloosahatchee Marl. The formation is of Pleistocene Age and consists of alternating beds of marine shells and freshwater limestones.

SOILS

The Caloosahatchee River Basin soils are predominately Spodosols with some Entisols, Histols south of the river, and miscellaneous types in coastal areas. Spodosols are dominated by somewhat poorly to poorly drained sandy soils with dark sandy subsoil layers. They have a subsurface zone where there has been an accumulation of iron, aluminum, and/or organic matter that has cemented into a layer that may inhibit water flow. Entisols are new or recent soils of limestone origin, underlain by marl and/or limestone. They are dominated by very poorly drained, coarse and thin, sandy soils. Histols are organic soils such as muck and peat. They are very poorly drained soils underlain by marl and/or limestone. Coastal sediments mostly consist of Entisols and Histols

CLIMATE

The Caloosahatchee Basin is located in an area that overlaps both a humid subtropical and a tropical savanna climate (Kőppen Climate Types). A tropical savanna climate is characterized by more sharply delineated wet and dry seasons and monthly temperature averages greater than 64˚F. In the wet season, monthly rainfall may exceed 10 inches. A humid subtropical climate has less extreme rainfall fluctuations between wet and dry seasons and some months have an average temperature less than 64˚F.

Average yearly rainfall is approximately 52 inches within the basin, with monthly averages ranging from 2 to 10 inches. Two-thirds of the annual rainfall occurs in the wet season from May to October. There is also a high variability in rainfall at different locations in the watershed (Fig 2.3). The inland portion of the watershed receives more rain than the coast during the dry season (Fig 2.4). On average the wet season rainfall is greater along the coast. Although November is the driest month, April is the month with the greatest water use demand.

Thunderstorms are frequent during the wet season in Southwest Florida. In Lee County, thunder occurs on every two out of three days between June and September (Fernald & Purdum 1998). Storms are usually brief but intense and peak during the late afternoon or early evening hours.

Tropical storms and hurricanes that affect the area originate in the Atlantic Tropical Cyclone Basin. This area includes the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Hurricane season extends from June through November and peaks in September and October when ocean temperatures are warmest and humidity is highest. Major effects from these storms are flooding, from rainfall and wind-generated tides and waves, storm surge, wind damage, and flushing of the river and estuary.

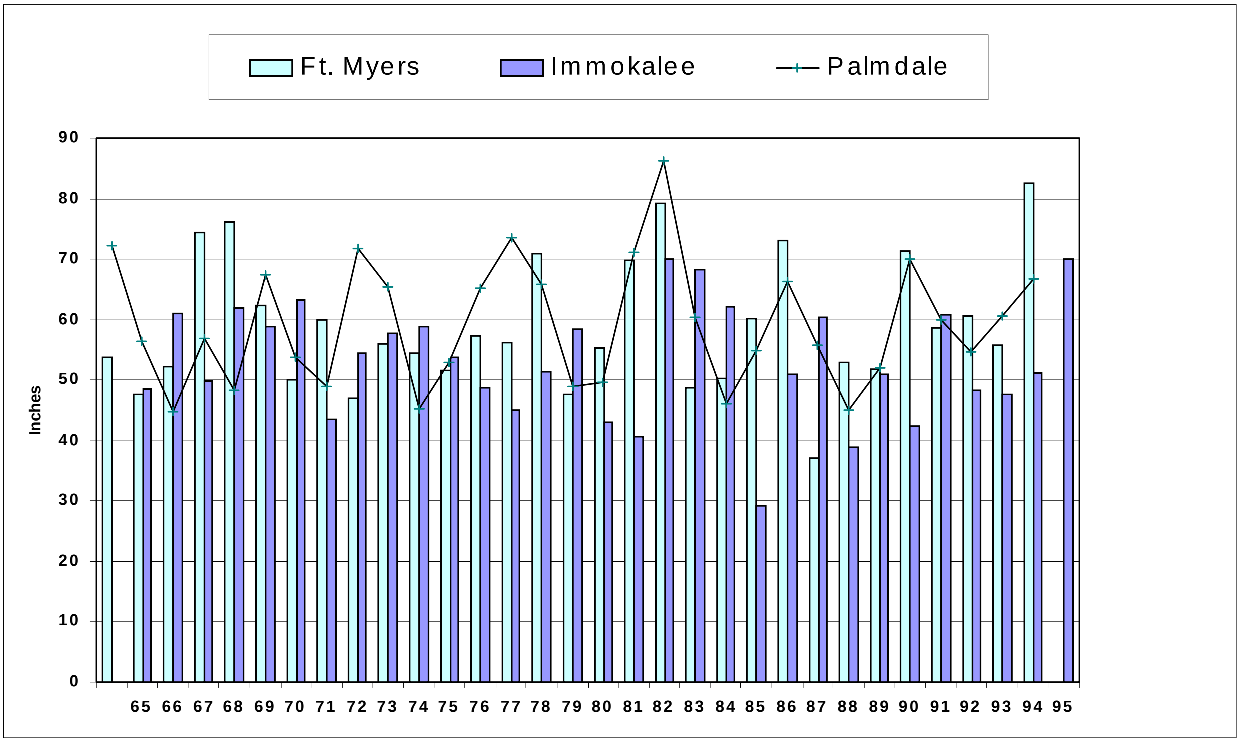


Figure 2.3 Variation from Annual Average Rainfall in the Caloosahatchee Watershed.

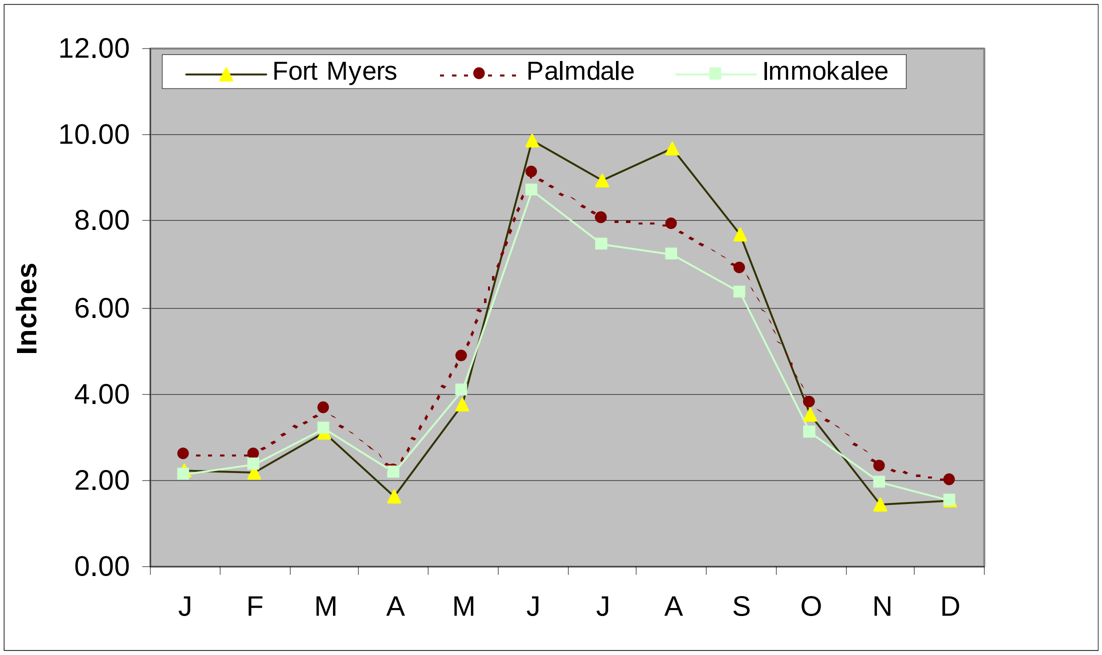


Figure 2.4 Spatial Variability in Average Monthly Rainfall in the Caloosahatchee Watershed

Water use demand is strongly related to evapotranspiration. Evapotranspiration (ET) is the sum of evaporation and transpiration and is commonly expressed in inches per year over a land area. Evapotranspiration is driven by solar radiation subject to the availability of water. Potential ET, the evapotranspiration that would occur from a well-watered short grass is approximately 59 inches per year in Southwest Florida. The actual ET is approximately 45 inches indicating the lack of available water during the dry-season. Annual PET varies from year to year as a function of local cloud cover as well as long term cyclic effects (Fig. 2.5). The excess of average precipitation over ET is equal to the combined amounts of average surface water runoff and average groundwater recharge. The ET increases from Ft. Myers to Lake Okeechobee as a result of decreasing cloud cover.

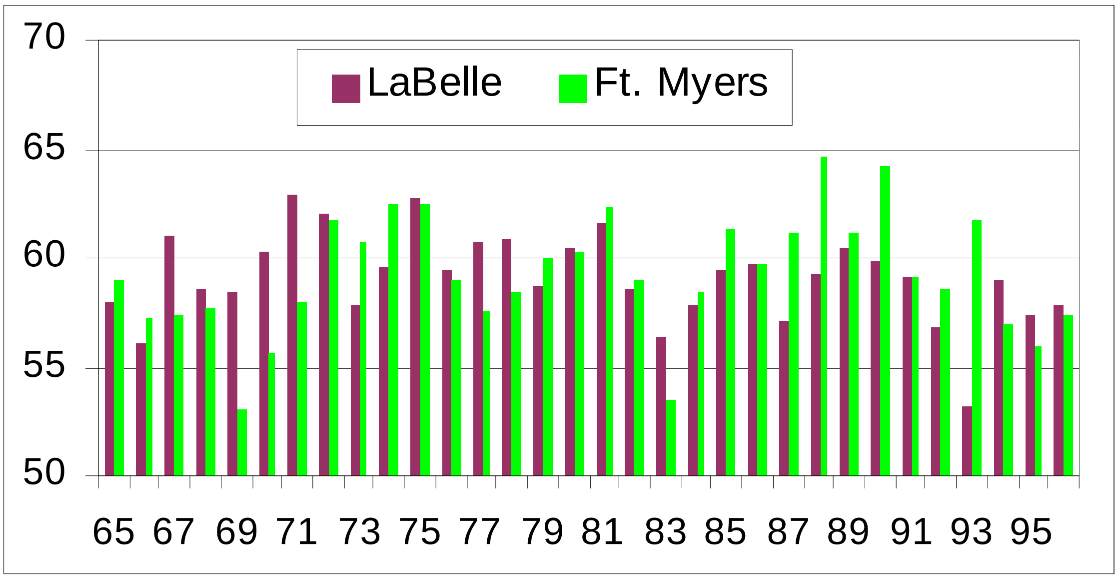


Figure 2.5. Annual and spatial variation in potential Evapotranspiration in southwest Florida.

WATER QUALITY

A critical relationship exists between water quality and human activity, including the withdrawal of water for supply. Increased withdrawals may cause a rise in the concentrations of impurities in the remaining water. Other human activities such as waste disposal and pollution spillage have the potential of degrading ground and surface water systems.

Water quality within the Caloosahatchee River basin is threatened by altered freshwater inputs, nutrient loads from agricultural activities, anthropogenic organic compounds, trace elements, as well as overall urban growth and development within the watershed. The integrity of riverine and estuarine ecosystems is dependent on water quality. As water quality diminishes, so does the overall quality of the system.

In 1976 it was determined that water quality data was needed to determine the health of the Caloosahatchee River. A baseline water quality database was created in 1978, yielding a database, which has helped the SFWMD determine management practices within the Caloosahatchee basin and watershed. Recently, data has been collected and complied from Lee

County, the City of Cape Coral, East County Water Control SFWMD, and SFWMD to evaluate the water quality from the urban portion of the Caloosahatchee watershed. Average nutrient concentrations were calculated for individual sub-basins and primary basins, and average nutrient loads were calculated for the primary basins.

The SFWMD is continuing water quality monitoring within the Caloosahatchee River through contracts with local and state agencies. Several projects incorporate water quality monitoring, including the SFWMD's VEC (Valued Ecosystem Component) study, and the South Florida Restudy.

The Florida Center for Environmental Studies (FCES) is currently monitoring eight water quality sites within the Caloosahatchee River and Estuary System. These sites are between Shell Point, at the mouth of the river, to just above S-79 W.P. Franklin Lock. Each of the eight sights are monitored monthly and samples are taken from two fixed depths within the water column. The FCES is also performing water quality biomonitoring using the freshwater grass *Vallisneria americana* (tape grass) to determine the effects of freshwater pulsing from Lake Okeechobee. This data will help to determine a pulse schedule that will help ensure the integrity of the freshwater grass community as well as the estuarine ecosystem.

Environmental Research and Design Inc., a consulting firm from Orlando, will conduct event sampling. Their data will be used to determine nutrient loading in the Caloosahatchee Estuary and the response of estuarine nutrient concentrations to external inputs. By identifying rates of nutrient loading from wastewater treatment facilities, and rivers and streams, nutrient inputs can be ranked in order of importance. The project will provide a data set that can be used to quantify the degree to which nutrient concentrations in the estuary depend on loading from external sources.

The U.S. Geological Service was contracted to sample bottom sediments from 35 sites in the Calooshatchee Estuary, including upstream of S-79. This project will provide the SFWMD with a complete assessment of total nitrogen, phosphorus, and potential toxic substances within the estuary. Other sample sites for this project are located in San Carlos Bay, Estero Bay, and Pine Island Sound. A final report will be submitted to the SFWMD in the fall of 1999.

EXISTING LAND USE

In general, land use in the Caloosahatchee Water Management Planning Area is predominantly rural and agricultural in nature in the eastern portion of the watershed and urban in the western portion of the watershed.

The predominant land use in the Caloosahatchee Water Management Planning Area is agricultural and is expected to remain so in the future. Citrus is the dominant irrigated crop in the basin and occupies over 91,000 acres, according to the 1995 Land Use Coverage (SFWMD). Over the past two decades, Southwest Florida has had the fastest growing citrus acreage in the state. This is associated with the movement of citrus southward from Central Florida following several severe winter freezes in the mid-1980s.

Sugarcane, with an estimated 75,000 acres, according to the 1995 Land Use Coverage, closely follows citrus in dominance. It is produced in the Caloosahatchee watershed in close vicinity to

Lake Okeechobee, in Hendry and Glades counties, where transportation costs to the mills can be minimized. Sugarcane acreage has continued to increase since 1995, and is expected to continue to increase in the future.

Native/natural land uses are also predominant in the basin, however can be expected to decrease as the watershed is further transformed into agriculture and urban uses. Urban land use follows behind, and is predominant in the western portion of the basin.

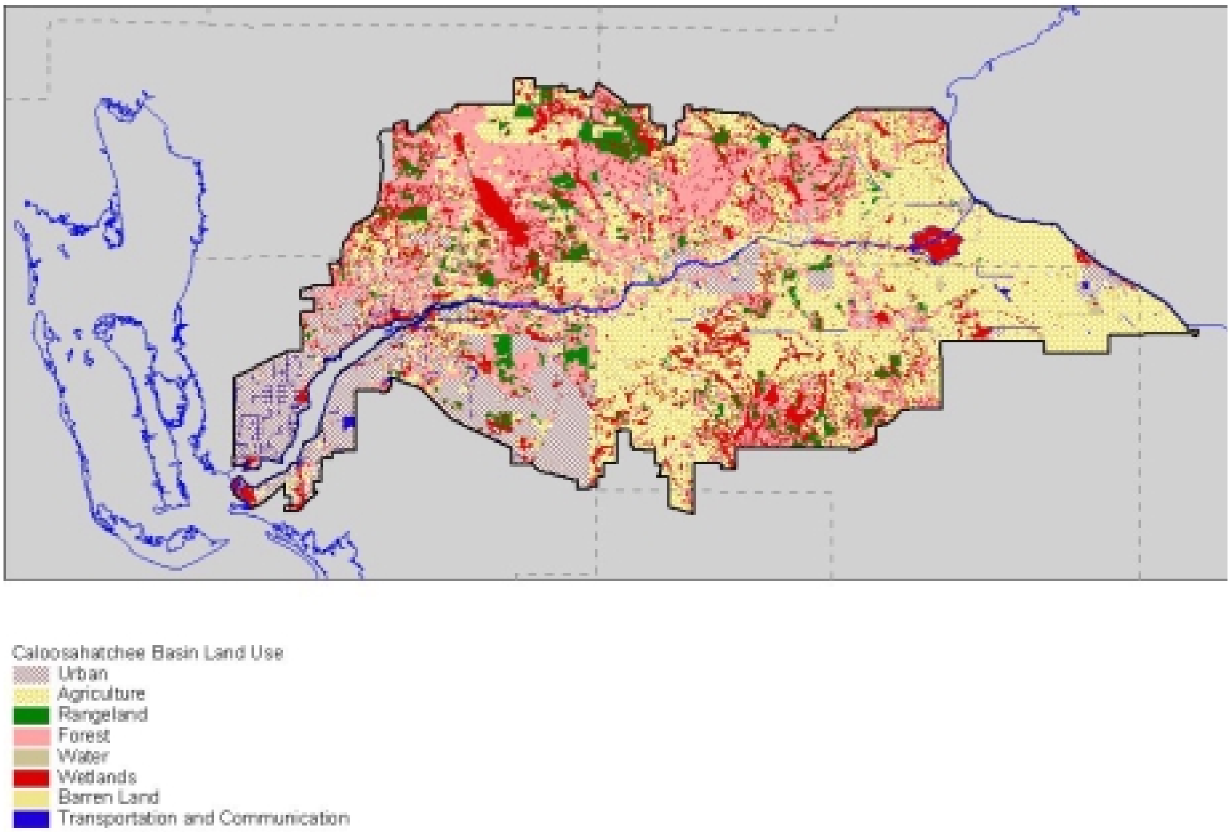


Figure 2.6 1995 Caloosahatchee Basin Land Use

NATURAL SYSTEMS

The Caloosahatchee Basin contains a variety of natural systems, ranging from an estuarine system with mangrove forests and seagrass beds to inland freshwater-forested shrub, herbaceous wetlands, and upland habitats. Although physically separate, these systems form an ecological continuum.

Estuary

The Caloosahatchee River Estuary is a large system where the waters of the Gulf of Mexico mix with the freshwater inflows from the river, sloughs, and overland sheetflows in the basin. The area is characterized by a shallow bay, extensive seagrass beds, and sand flats. Extensive mangrove forests dominate undeveloped areas of the shoreline. Southwest Florida estuaries are used by more than 40 percent of Florida's rare, endangered, and threatened species.

Coastal areas subject to tidal inundation support extensive mangrove forests and salt marsh areas. Coastal mangroves discourage erosion from storms and high tides, and assimilate nutrients to produce organic matter, which forms the base of the food chain. Four Species of mangroves as commonly found along the South Florida coastline: White mangrove (*Laguncularia racemosa*); Black mangrove (*Avicennia germinans)*; Red Mangrove (*Rhizophora mangle*); and Buttonwood (*Conocarpus erectus).* Mangroves and salt marsh communities serve as important nursery and feeding grounds for many economically important species of finfish and shellfish, which in turn support migratory waterfowl, shore bird and wading bird populations. These brackish water communities were once commonly distributed along the entire coastline but are now found in greatest abundance in southwest Collier County and southern Lee County.

Maintenance of appropriate freshwater inflows is essential for a healthy estuarine system. Preliminary findings indicate that optimum inflows to the Caloosahatchee Estuary should have mean monthly values between 300 and 2,800 cubic feet per second (cfs). Average daily flows between January 1988 and June 1999 were approximately 500 cfs. Low flows of 0 cfs and high flows as high as 17,283 cfs were recorded during the same period. Excessive freshwater inflows to the estuary result in imbalances beyond the tolerances of estuarine organisms. The retention of water within upland basins for water supply purposes can reduce inflows into the estuary and promote excessive salinities. Conversely, the inflow of large quantities of water into the estuary as a result of flood control activities can significantly reduce salinities and introduce stormwater contaminants. In addition to the immediate impacts associated with dramatic changes in freshwater inflows, long-term cumulative changes in water quality constituents or water clarity may also adversely affect the estuarine community.

Estuarine biota is well adapted to and depends upon natural seasonal changes in salinity. The temporary storage and concurrent decrease in velocity of floodwaters within upstream wetlands aid in controlling the timing, duration, and quantity of freshwater flows into the estuary. Upstream wetlands and their associated ground water systems serve as freshwater reservoirs for the maintenance of base flow discharges into the estuaries, providing favorable salinities for estuarine biota. During the wet season, upstream wetlands provide pulses of organic detritus, which are exported downstream to the brackish water zone. These materials are an important link in the estuarine food chain.

Tape grass, *Vallisneria americana,* is one of the dominant submerged aquatic plants in the upper Caloosahatchee River Estuary, and occurs in well-defined beds in shallow waters. *V. americana* is thought to be an important habitat for a variety of freshwater and estuarine invertebrate and vertebrate species, including some commercially and recreationally important fish (Bortone and Turpin 1998). Additionally, it can serve as a food source for the Florida manatee.

Estuaries are important nursery grounds for many commercially important fish species. Many freshwater wetland systems in the planning area provide base flows to the estuary. Wetlands as far inland as the Okaloacoochee Slough in Hendry County contribute to the base flows entering the estuarine system. Maintenance of these base flows is crucial to propagation of many fish species, such as grouper, snapper, and spotted seatrout, which is the basis of extensive commercial and recreational fishing industries.

The estuarine environment is sensitive to freshwater releases, and disruption of the volume, distribution, circulation, and temporal patterns of freshwater discharges could place severe stress on the entire ecosystem. "Such salinity patterns affect productivity, population distribution, community composition, predator-prey interactions, and food web structure in the inshore marine habitat. In many ways, salinity is a master ecological variable that controls important aspects of community structure and food web organization in coastal systems" (Myer and Ewel, 1990). Other aspects of water quality, such as turbidity, dissolved oxygen, nutrient loads, and toxins, also affect functions of these areas (USDA, 1989; Myers and Ewel, 1990).

Research is currently being conducted by the Florida Center for Environmental Studies, in conjunction with the SFWMD, to investigate the *in situ* influence of freshwater inflow and salinity on tape grass and to determine if freshwater inflow requirements are needed to permit a "healthy", thriving ecosystem in the upper portions of the Caloosahatchee Estuary. This work will help the SFWMD in its charge to make informed management decisions regarding optimal flow volumes and discharge schedules to preserve, increase, or maintain existing submerged aquatic vegetation present in the upper portions of the Caloosahatchee Estuary as well as the communities of organisms associated with it.

Also, the SFWMD and the U.S. Army Corps of Engineers (USACE) are conducting a research study to characterize seasonal fluctuations of submerged aquatic vegetation (SAV) in the upper Caloosahatchee Estuary, lower Caloosahatchee Estuary, San Carlos Bay and Pine Island Sound. SAV will be mapped, on the basis of distribution and proximity to significant freshwater input, using Submersed Aquatic Vegetation Early Warning System, which was developed by scientists at the USACE-Waterways Experiment Station. This project will provide information on spatial and temporal variations in biotic communities needed to determine biotic status and trends. Furthermore, the project will provide information on the effect of management actions on ecosystems to researchers and managers assessing the success of future water management policies designed to protect and enhance SAV communities.

Additionally, the University of Florida Coastal and Oceanographic Engineering Department are developing a coupled circulation/water quality model for the Charlotte Harbor Estuarine system for the SFWMD. The model will be developed in three phases. Phase I includes a preliminary 3-D circulation model will be developed and calibrated with available hydrodynamic data and then applied to address the impact of the Caloosahatchee River Estuary on circulation in Pine Island Sound, with particular focus on the effect of the Sanibel Causeway. This is scheduled for completion December 1999. Phase II will review and analyze available water quality data and a 3-D water quality model will be developed. An assessment of the effects of the Sanibel Causeway on circulation and salinity will be accomplished. Phase III will calibrate the coupled hydrodynamics and water quality models and apply them to address the impact of loading from the Caloosahatchee watershed on the water quality in the Caloosahatchee Estuary, San Carlos Bay, and Pine Island Sound. Phase II is scheduled for completion in late 2000 and Phase III in 2001.

Inland Resources

Inland portions of the Caloosahatchee Basin include freshwater swamps, sloughs, and marshes. These wetland areas serve as important habitat for a wide variety of wildlife and have numerous hydrological functions. Before development of South Florida, inland areas were comprised of vast expanses of cypress and hardwood swamps, freshwater marshes, sloughs, and flatwoods. Scattered among these systems were oak/cabbage palm and tropical hammocks, coastal strand and xeric scrub habitats. A large portion of the area contained seasonally flooded wetlands which sheetflowed fresh water from northeast to southwest. Water bodies within the Caloosahatchee Basin include natural lakes, man-made surface water impoundments, rivers, and creeks.

Wetlands

Wetlands are transitional lands between uplands and aquatic systems and are typically defined by vegetation, soils, and hydrology. Chapter 62-340, Florida Administrative Code (F.A.C.), provides the statewide methodology for delineating wetlands in Florida. In part, Chapter 62-340 includes the following definition of wetlands: "Those areas that are inundated or saturated by surface water or groundwater at a frequency and a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Wetlands within the planning area include swamps, marshes, cypress domes and strands, sloughs, wet prairies, wetland hardwoods, and mangrove swamps.

Wetlands perform a number of hydrologic and biologic functions valuable to man. Hydrologic functions include receiving and storing surface water runoff. This is important in controlling flooding, erosion, and sedimentation. Surface water that enters a wetland is stored until the wetland's overflow capacity is reached and water is slowly released downstream. As the flow of water is slowed by wetland vegetation, sediments in the water (and chemicals bound to the sediments) drop out of the water column, potentially improving water quality. Additionally, within cypress wetlands, the trees are deciduous which reduces water loss due to transpiration during the dry season. Wetlands also function hydrologically as groundwater recharge-discharge areas. Wetlands recharge the groundwater when the water level of a wetland is higher than the water table. Conversely, groundwater discharge to wetlands may occur when the water level of the wetland is lower than the water table of the surrounding land.

Biological wetland functions include providing habitat for fish and wildlife, including organisms classified as endangered, threatened, or species of special concern. Some species depend on wetlands for their entire existence, while other semi-aquatic and terrestrial organisms use wetlands during some part of their life cycle. Their dependence on wetlands may be for over-wintering, residence, feeding and reproduction, nursery areas, den sites, or corridors for movement. Wetlands are also an important link in the aquatic food web. They are important sites for microorganisms, invertebrates, and forage fish, which are consumed by predators such as amphibians, reptiles, wading birds, and mammals.

Inland, or freshwater, wetlands within the planning area can be grouped into three major categories based in hydroperiod: permanently flooded or irregularly exposed; seasonally or semipermanently flooded; temporarily flooded or saturated; and upland. The Florida Land Use

Cover and Classification System (FLUCCS) was used to delineate wetland systems within the Caloosahatchee Basin. The FLUCCS map was created in 1998 using 1994-1995 aerial photography and is the most accurate representation of the Basin. The hydroperiod categories were created by combining FLUCCS coverage classifications with the National Wetlands Inventory hydrologic classifications. The hydrologic categories are broadly defined as:

Permanently Flooded or Irregularly Exposed. Water covers the substrate throughout the year in all years or the substrate is exposed by tides less often than daily. This corresponds to lakes, reservoirs, embayments, tidal mangrove swamps, salt marsh, and major springs (FLUCCS codes of open water, level-1 = 500).

Seasonally or Semipermanently Flooded. Surface water persists throughout the rainy season and much of the dry season in most years. When surface water is absent, the water table is at or very near the land surface. Seasonally flooded soils are saturated. This corresponds to swamps, sloughs, mixed wetland hardwoods, cypress, wetland forest mixed, freshwater marshes sawgrass or cattail, wet prairies, emergent and submergent aquatic vegetation (FLUCCS codes of wetlands, level-1 = 600).

The hydric pine flatwoods habitat is dominated by a southern slash pine (*Pinus elliottii* var. *densa*) upperstory with a wetland plant understory, unique to south Florida. The wetland understory can be any, or a variety, of wetland plant community types including wet prairie, freshwater marsh, freshwater slough, freshwater seasonal ponds, cordgrass prairie, beakrush prairie, scrub cypress, dwarf cypress, or hatrack cypress. Hydric pine flatwoods are distinct from mesic and xeric pine flatwoods in the absence of understory dominance by saw palmetto (*Serenoa repens*) and xeric scrub species. Mid-story plants of hydric pine flatwoods include the nearly ubiquitous natives: cabbage palm (*Sabal palmetto*); wax myrtle (*Myrica cerifera*); strangler fig (*Ficus aurea*); the exotic invaders: Brazilian pepper (*Schinus terebinthifolius*) and melaleuca (*Melaleuca quinquinervia*); and the shrub species characteristic of mixed hardwood swamp forest and cypress forest of south Florida: red maple (*Acer rubrum*), dahoon holly (*Ilex cassine*), and buttonbush (*Cephalanthus occidentalis*). The hydric pine flatwoods act as both uplands, in dry season, and wetlands, in the summer and fall. Soils are sandy and permeable with some marl in Collier County. Hydric pine flatwoods provide habitat for 10 federal and 75 state listed species.

Temporarily Flooded or Saturated. Surface water is present for brief periods during the rainy season, but the water table usually lies well below the soil surface for most of the year. Plants that grow in both uplands and wetlands are characteristic of this water regime. The substrate is saturated to the surface throughout the rainy season or for extended periods during the rainy season in most years. Surface water is seldom present. This corresponds to cypress-pine-cabbage palm, wet prairie-with pine, intermittent ponds, pine-mesic oak, brazilian pepper, melaleuca, and wax myrtle-willow (FLUCCS codes of level-3 = 600).

Two significant natural wetland systems in the Caloosahatchee Basin are Twelve Mile Slough and the Okaloacoochee Slough. Both are located south of the river. The Twelve-Mile Slough is located in Hendry County and is a tributary to the much larger and regionally significant Okaloacoochee Slough. It covers 3,300 acres and contains a mosaic of freshwater wetlands, as well as pine flatwoods and oak/cabbage palm hammocks. Surface water storage in the numerous wetlands provides for groundwater recharge of the underlying Surficial Aquifer and provides surface water supply to the Caloosahatchee River.

A portion of the Okaloacoochee Slough is located in the Caloosahatchee watershed, in Hendry County. It flows both north, toward the Caloosahatchee River, and south toward Collier County and is a major headwater for the Fakahatchee Strand and the Big Cypress National Preserve. This slough system is composed largely of herbaceous plants with trees and shrubs scattered along its fringes and central portions. Its extensive network of sloughs and isolated wetlands store wet-season runoff from the surrounding uplands and provide year-round base flow to downstream natural areas. The Okaloacoochee Slough, Harn's Marsh, and Orange River system provide habitat for a variety of wildlife such as the endangered Florida panther.

The mesic oak hammock is a closed canopy forest, dominated by temperate evergreen tree species, primarily live oak, with cabbage palms and some pines, that is naturally protected from fire by its position on the landscape, often adjacent to rivers, streams, and swamps. Tropical species are common in the shrub layer and become increasingly important in the canopy at the southern end of the range,. Soils are moist due to a dense litter layer and humid conditions under the closed canopy, but are rarely inundated. Mesic hammocks provide habitat for five federal and 23 state listed species.

Wetland systems north of the river include portions of Fisheating Creek and Telegraph Cypress Swamp. Fisheating Creek is a major wetland in western Glades County. It is an extensive riverine swamp system that forms a watershed covering hundreds of square miles. Although Fisheating Creek is located in the Kissimmee Basin Planning Area, it delineates the northern boundary of the Caloosahatchee Basin. Fisheating Creek is the only free flowing tributary to Lake Okeechobee. The creek attenuates discharges from heavy storm events and improves water quality before the storm water enters the lake. The creek also serves as a feeding area for wading birds such as the endangered wood stork, white ibis, and great egrets, when stages in the marshes surrounding Lake Okeechobee are too high.

Telegraph Cypress Swamp is located in eastern Charlotte County. It is a diverse system with a mixture of hydric flatwoods, cypress strands, and marshes. Within Lee County there are several free flowing creeks that enter the river west of S-79 such as Hancock, Yellow Fever, Powell, Doughtrey, Bedman and Hickey. The headwaters for Hancock, Yellow Fever, Powell, and Doughtrey creeks are in Charlotte County.

Thirty-five side channels, or oxbows, of various sizes and geomorphic configurations are found along the channelized river from the town of LaBelle down to the W.P. Franklin Lock and Dam. The ecological condition of these oxbows varies from reasonably good, in those few with significant flow-through, to very poor in those where flow is restricted or blocked and significant organically rich sediments have accumulated (Cummins and Merritt, 1999). The long-term management objective for these oxbows is to enhance their capacity as water quality filters and for off-channel water storage during wet periods by rehabilitating them to flow-through conditions.

Research is being conducted to assess the present ecological state of the river's oxbows. Ten oxbows have been selected for a study that includes water quality sampling; remote sensing and

GIS mapping; channel geomorphic and plant bed measurements; plant bed and sediment macroinvertebrate functional groups; and fish diversity and functional groups. To date, the macroinvertebrate functional group analysis has been completed and recommendations have been made for oxbow restoration based on this data. The other components of the study are to be completed in April 2000. At that time, final recommendations for oxbow restoration will be made.

Uplands

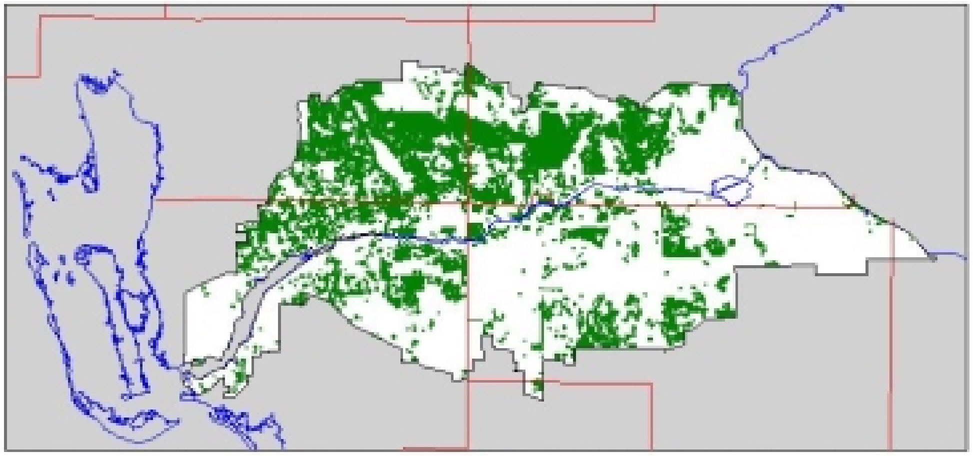
Uplands are an important part of the natural system. Upland communities in the Caloosahatchee Basin include pine flatwoods, tropical hammocks,mesic oak, dry prairie, and xeric scrub communities, with flatwoods being the dominant upland habitat. Flatwood communities are divided into two types: dry and hydric. Dry flatwood communities are characterized by an open canopy of slash pine with an understory of saw palmetto. However, dry flatwoods are located in a slightly higher elevation in the landscape and are rarely inundated. Hydric flatwood communities (wetlands) are vegetatively similar to dry flatwoods.

Large areas of flatwoods are found throughout Hendry and Lee counties, as well as portions of Charlotte, Glades, and Collier counties. Upland flatwoods are the native habitats most affected by the expansion of citrus into southwest Florida. Flatwoods are important habitat for a number of threatened and endangered species such as the Florida panther, Florida black bear, eastern indigo snake, red-cockaded woodpecker and the gopher tortoise. Pine flatwoods have a greater richness of vertebrate species than either sand pine or dry grass prairies (Myers and Ewel, 1990).

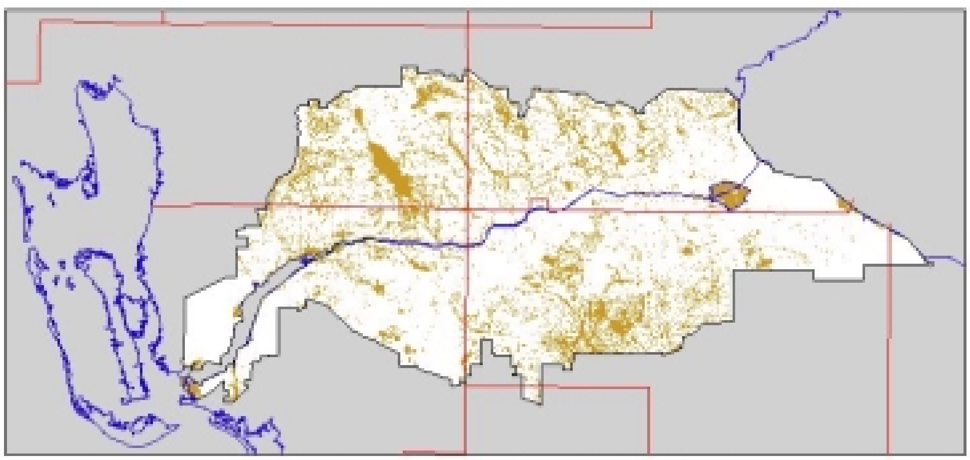
Tropical hammocks are rare in the basin. This diverse woody upland plant community occurs on elevated areas, often in Indian shell mounds along the coast, or on marl or limestone outcroppings inland. As a result of urban development, tropical hammocks are among the most endangered ecological communities in South Florida.

Xeric, sand pine, and oak scrub communities most commonly occur along ridges and ancient dunes. They are often associated with relic sand dunes formed when sea levels were higher. These well-drained sandy soils are important aquifer recharge for coastal communities. The sand pine and oak scrub is the most endangered ecological community present within the planning area. It is rapidly being eliminated by conversion to other land uses.

Upland plant communities serve as recharge areas, absorbing rainfall into soils where it is distributed into plant systems or stored underground within the aquifer. Groundwater storage in upland areas reduces runoff during extreme rainfall events, while plant cover reduces erosion and absorbs nutrients and other pollutants that might be generated during a storm event. With few exceptions the functions and values attributed to wetlands also apply to upland systems. Upland/wetland systems are ecological continuums, existing and adapting to geomorphic variation. The classification of natural systems is artificial and tends to convey a message that they survive independently of each other. In reality, wetland and upland systems are interdependent. To preserve the structure and functions of wetlands, the linkage between uplands and wetlands must be maintained (Mazzotti et al., 1992).



Caloosahatchee River Basin Uplands (1995 FLUCCS)



Caloosahatchee River Basin Wetlands (1995 FLUCCS)

Figure 2.7 Caloosahatchee Basin Uplands and Wetlands

Fauna

Southwest Florida, in general, has a rich diversity of native fauna. These include endemic and sub-tropical species that cannot be found anywhere else in the United States. The Caloosahatchee Basin supports a diverse and abundant array of fish and wildlife species, including many endangered and threatened species (Table 2.1). The Caloosahatchee Estuary serves as a particularly important center of abundance in the state for the Florida Manatee. Likewise, Telegraph Swamp and Corkscrew Regional Ecosystem are Strategic Conservation Areas for the Florida Panther (Cox et al., 1994).

The Florida Fish and Wildlife Conservation Commission in their Closing the Gaps in Wildlife Habitat Conservation System (GAPS) described habitat in Florida that should be conserved if key components of the state's biological diversity are to be maintained. Habitat areas identified for each species are called Strategic Habitat Conservation Areas (SHCA) because of their importance in providing some of Florida's rarest species with the habitat needed for long-term persistence (Cox et al., 1994).

According to Florida Fish and Wildlife Conservation Commission's Closing the Gaps in Florida's Wildlife Habitat Conservation System (Cox et al., 1994), the region was identified as possibly the most important area in Florida in terms of maintaining several wide-ranging species that make up an important component of wildlife diversity in the state. Furthermore, the southwest Florida region is a unique place for the concentration of migratory species. Many birds use the area for wintering, breeding, feeding, and nesting. In addition, several species of marine fish depend on the fresher water estuary as a spawning and nursery area.

Table 2.1 Listed Faunal Species in the Caloosahatchee Basin (USFWS 1998 & FGFWFC 1997)

Scientific Name	Common Name	Federal Status	State Status
AMPHIBIANS			
Rana capito	Gopher frog		SSC
REPTILES			
Alligator mississippiensis	American alligator	T(S/A)	SSC
Caretta caretta	Loggerhead sea turtle	T	T
Chelonia caretta	Green sea turtle	E	E
Dermochelys coriacea	Leatherback sea turtle	E	E
Drymarchon corais couperi	Eastern indigo snake	E	T
Eretmochelys imbricata	Hawksbill sea turtle	E	E
Gopherus polyphemus	Gopher tortoise		SSC
Lepidochelys kempii	Kemp's ridley sea turtle	E	E
Crocodylus acutus	American crocodile	E	E
Pituophis melanoleucus mugitus	Florida pine snake		SSC
BIRDS			
Ajaia ajaja	Roseate spoonbill		SSC
Aphelocoma coerulescens	Florida scrub-jay	T	T
Aramus guarauna	Limpkin		SSC
Caracara plancus	Audubon's crested caracara	T	T
Charadrius alexandrinus tenuirostris	Southeastern snowy plover		T
Charadrius melodus	Piping plover	T	T
Egretta caerulea	Little blue heron		SSC
Egretta thula	Snowy egret		SSC
Egretta tricolor	Tricolored heron		SSC
Eudocimus albus	White ibis		SSC
Falco peregrinus tundrius	Arctic peregrine falcon		E
Falco sparverius paulus	Southeastern American kestrel		T

Grus canadensis pratensis	Florida sandhill crane		T
Haematopus palliatus	American oystercatcher		SSC
Haliaeetus leucocephalus	Bald eagle	T	T
Mycteria americana	Wood stork	E	E
Pelecanus occidentalis	Brown pelican		SSC
Picoides borealis	Red-cockaded woodpecker	E	T
Phyncops niger	Black skimmer		SSC
Rostrhamus sociabilis plumbeus	Everglades snail kite	E	E
Speotyto cunicularia floridia	Florida burrowing owl		SSC
Sterna antillarum	Least tern		T
MAMMALS			
Blarina brevicauda shermanii	Sherman's short-tailed shrew		SSC
Felis concolor coryi	Florida panther	E	E
Felis concolor	Mountain lion	T	E
Mustela vison evergladensis	Everglades mink		T
Oryzomys palustris sanibelli	Sanibel Island rice rat	E	SSC
Podomys floridanus	Florida mouse		SSC
Sciurus niger avicennia	Big Cypress fox squirrel		T
Trichechus manatus latirostris	Florida manatee (subspecies of the West Indian manatee)	E	E
Sciurns niger shermani	Sherman's fox squirrel		SSC
Ursus americanus floridanus	Florida black bear		T
FISH			
Acipenser oxyrhynchus	Atlantic sturgeon	SSC	T
Centropomus undecimalis	Common snook	SSC	
Cyprinodon variegatus hubbsi	Lake Eustis pupfish	SSC	

T = Threatened E = Endangered SSC = Species of Special Concern
S/A = Due to similarity of appearance to endangered species.

Florida Panther

The Florida panther is a large, carnivorous cat with a long tail and a short stiff pelt. Its color varies from a pale brown to rust, with dull white or buff underparts and a dark brown or blackish tail tip, ears and nose (sides). Adult male panthers reach a length of seven feet (from nose to tip of tail) and average around 120 pounds in weight. Female are smaller, with an average weight of 75 pounds and a length of 6 feet. The diet of the Florida panther varies geographically. Studies of south Florida populations show that white-tailed deer and feral hogs are preferred prey (Maehr et al., 1990) but they also prey on raccoons, armadillos, rabbits, birds, and small alligators (Logan et al., 1993).

The Florida panther is one of the most endangered large mammals in the world (USFWS, 1998). Currently, the population is estimated to be at 30-50 adult panthers (Cox et al., 1994). The U.S. Fish and Wildlife Service (USFWS) has developed species and habitat-level recommendations for its protection in the Multi-species Recovery Plan for Threatened and Endangered Species of South Florida (USFWS, 1998). Early conservation and management efforts involved land acquisition. As this conservation effort continues, present recovery efforts are placing emphasis on three major areas: (1) protection and enhancement of the sole remaining wild population, associated habitats, and prey resources; (2) panther's historic range.

The USFWS (Logan et al., 1993) has identified panther habitat warranting preservation. Information used in this identification process included telemetry data, a forested habitat analysis, county land use plans, and land ownership patterns. Native habitat was identified using aerial photographs and verified through ground truthing. To meet the needs of the panther, habitat had to meet the following criteria: (1) must be sufficient size to support several panthers or be contiguous with occupied range; (2) must contain significant forest cover; and (3) contain few residences and few highways. This habitat was then classified as either Priority 1 or 2, based on panther use and/or habitat quality.

Priority 1 Habitats, as defined by USFWS (Logan et al., 1993), are the lands most frequently used by the panther and/or lands of high quality native habitat suitable for the panther that should be preserved first. The preservation option utilized will depend on landowner preference, agency interest, ownership patterns, fiscal limitations, and time constraints.

Priority 2 Habitats are the lands less frequently used by the panther and/or lands of lower quality native habitat interspersed with intensive agriculture. These lands serve as buffer zones to urban developments and other forms of undesirable encroachment and should be preserved second. The preservation option utilized will depend on landowner preference, agency interest, ownership patterns, fiscal limitations, and time constraints.

Priority 1 and 2 Habitats that lay within the Caloosahatchee River Basin are shown in Figure 2.8

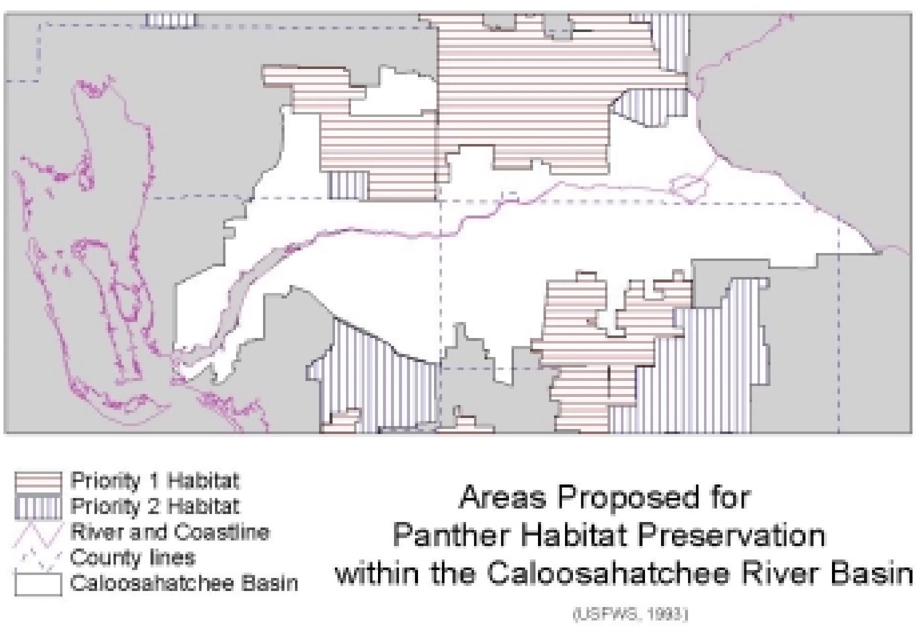


Figure 2.8 Priority 1 and 2 Panther Habitats

West Indian Manatee

The West Indian manatee is one of the most endangered marine mammals in coastal waters of the United States (USFWS, 1995). United States populations are limited primarily to Florida and Georgia. The Florida population is estimated to be at least 1,856 animals (USFWS, 1995).

The West Indian manatee is a large, gray or brown, aquatic mammal. Adults average about 11.5 feet in length and weigh 2,200 pounds (USFWS, 1995). They have no hind limbs, their forelimbs are modified as flippers, and their rounded tails are flattened horizontally. The skin of a manatee is wrinkled, rubber-like, and sparsely covered with short, thick hairs. Male and female manatees are similar in size and appearance (Rathburn, 1984).

Manatees inhabit bays, estuaries, canals, rivers, and coastal areas where seagrasses and other aquatic vegetation are common. They are primarily herbivores and feed on a variety of submergent, emergent, and floating vegetation. Manatees spend about 5 hours a day feeding and may consume 4 to 9 percent of their body weight in a day (USFWS Region 4, 1993). During cooler, winter months manatees aggregate in warm, natural springs and industrial outfalls. In the basin, Florida Power and Light Fort Myers Plant serves as a winter aggregation site, usually with aggregates of 25 or more animals (USFWS, 1995).

Lee County Division of Natural Resource Management has developed a plan to provide the basis for countywide protection of the Florida manatee. The plan provides a basis for continued long-term enhancement of the health and welfare of manatees and their habitat. The plan contains criteria for law enforcement, habitat protection, education programs, and management of manatee-human interactions (Lee County, 1999).

The USFWS (1995) has developed a recovery plan for the Florida manatee. The long-range goal of the plan is "restoring Florida manatees to optimum sustainable population levels under provisions of the Marine Mammal Protection Act of 1973, and maintaining them at those levels." To accomplish this, the plan establishes four objectives: (1) identify and minimize causes of manatee disturbances, injury, and mortality; (2) protect essential manatee habitat; (3) determine and monitor the status of manatee populations and essential habitat; and (4) coordinate recovery activities, monitor and evaluate progress, and update and/or revise the Recovery Plan (USFWS, 1995).

Eastern Indigo Snake

The eastern indigo snake is the largest nonpoisonous snake in North America. It is black, dorsally and ventrally, with a red or cream colored expansion of the chin and throat. It can reach lengths of greater than 100 inches. The eastern indigo snake frequents several habitat types including pine flatwoods, scrubby flatwoods, high pine dry prairie, tropical hardwood hammocks, edges of freshwater marshes, agricultural fields, and coastal dunes. They need a mosaic of habitats to complete their annual cycle (USFWS, 1998). Indigo snakes require sheltered refugia to shield them from cooler or desiccating conditions and are commonly found in association with gopher tortoise burrows.

The USFWS has developed species and habitat-level recommendations for the protection of the eastern indigo snake in the Draft Multi-Species Recovery Plan (USFWS, 1998). These include: (1) determine the distribution of the eastern indigo snake in South Florida; (2) protect and enhance existing populations of indigo snakes in South Florida; (3) protect indigo snakes in public and private lands; (4) enforce available protective measures; (5) conduct Section 7 consultations on Federal activities that may affect indigo snakes; (6) implement the USFWS South Florida Ecosystem Office's Indigo Snake Guidelines for Section 7 and 10 of the Endangered Species Act (ESA) and incorporate the guidelines into permits where feasible; (7) monitor indigo snake populations; and (8) improve public attitude and behavior towards the indigo snake.

Red-cockaded Woodpecker

The red-cockaded woodpecker is a small bird with a black and white barred back and wings and white cheeks and underparts. It is approximately 8-9 inches in length and has a wingspan of approximately 17 inches, with males slightly larger than females. The red-cockaded woodpecker's range corresponds closely to the distribution of southern pines. Nesting and roosting habitat is primarily located in pine stands, or pine-dominated pine/hardwood stands, with low or sparse understory and adequate old-growth pine (USFWS, 1998).

The USFWS developed species and habitat recommendations for the red-cockaded woodpecker in the Draft Multispecies Recovery Plan for South Florida (USFWS, 1998). These include: (1) determine distribution and status of red-cockaded woodpeckers; (2) develop a reserve design for red-cockaded woodpeckers; (3) protect, manage, and enhance red-cockaded woodpecker populations on public lands; (4) enforce available protective measures (Section 7 and 10 ESA); (5) conduct risk assessment analysis to determine the probability of persistence of red-cockaded woodpeckers in south Florida, given the current amount of available, suitable pineland habitat, and include pineland areas that could be restored or enhanced to become suitable habitat; (6) study the effects of habitat fragmentation due to urbanization; (7) monitor red-cockaded woodpecker subpopulations; (8) inform and involve the public; (9) prevent degradation of existing red-cockaded woodpecker habitat in south Florida; (10) prioritize areas identified in reserve design for management and acquisition; (11) protect red-cockaded woodpecker habitat on private lands though easements, acquisitions, and donations; (12) maintain adequate nesting habitat in addition to currently active clusters, to replace clusters abandoned or lost through mortality, and to provide for population expansion; (14) maintain adequate foraging habitat to support existing groups and to facilitate establishment of new territories; (15) support state land acquisition efforts; (16) prevent the loss and fragmentation of pine flatwoods within reserves; (16) restore and enhance red-cockaded woodpecker populations; (17) determine the amount of foraging habitat needed to sustain a group of woodpeckers in south Florida in both mesic and hydric pine flatwood habitats; (18) determine the potential carrying capacity for clusters of red-cockaded woodpeckers on existing public and private lands where suitable or restorable habitat exists; (19) monitor pineland habitat that is occupied by red-cockaded woodpeckers to insure public lands are managed to maintain habitat in suitable conditions for red-cockaded woodpeckers, and to assess when unmanaged areas become unsuitable; and (20) increase public awareness of pine flatwood communities.

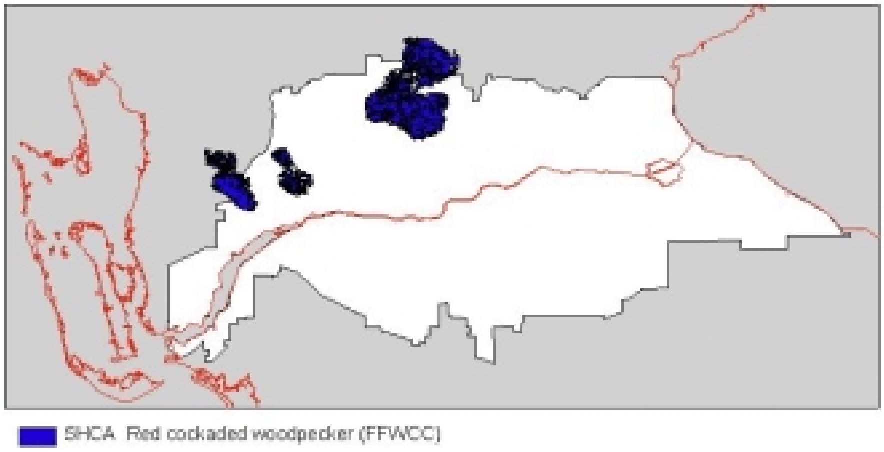


Figure 2.9 Strategic Habitat Conservation Areas for the Red Cockaded Woodpecker

Wood Stork

Wood storks are large, long-legged wading birds. They are approximately 50 inches tall, with a wing span of 60-65 inches. Their plumage is white except for some black in the wings and tail. Their head and neck are dark gray and unfeathered. The wood stork is largely colonial, nesting in rookeries and feeding in flocks. They are associated primarily with freshwater habitats for nesting, roosting, foraging, and rearing (USFWS, 1998).

Loss or degradation of wetlands in central and southern Florida is one of the principle threats to the wood stork. The USFWS has developed species and habitat-level recommendations for their protection in the Draft Multi-Species Recovery Plan of South Florida (USFWS, 1998). Recommendations include: (1) preventing degradation of nesting, foraging, and roosting habitats; (2) protecting and enhancing wood stork protection through provisions of Section 7 ESA; (3) determining the foraging ecology and behavior of wood storks; (4) protecting wood storks from mercury and other contaminants; (5) prioritizing habitats that need protection; (6) assisting private landowners in managing for wood storks by providing Best Management Practices, incentives, or management plans; (7) developing consistent with the Habitat Management Guidelines for Wood Storks (Ogden, 1990); (8) utilizing existing wetland regulatory mechanisms to protect foraging habitat in south Florida (Federal and State permitting actions); (9) developing Habitat Conservation Plans; (10) adaptive restoration and enhancement of suitable habitat; (11) enhancing breeding and wintering activities of wood storks in south Florida; (12) determining the effects of natural and human-caused hydrologic events on ecology of the wood stork prey base; and (14) acquire land identified as important to wood storks.

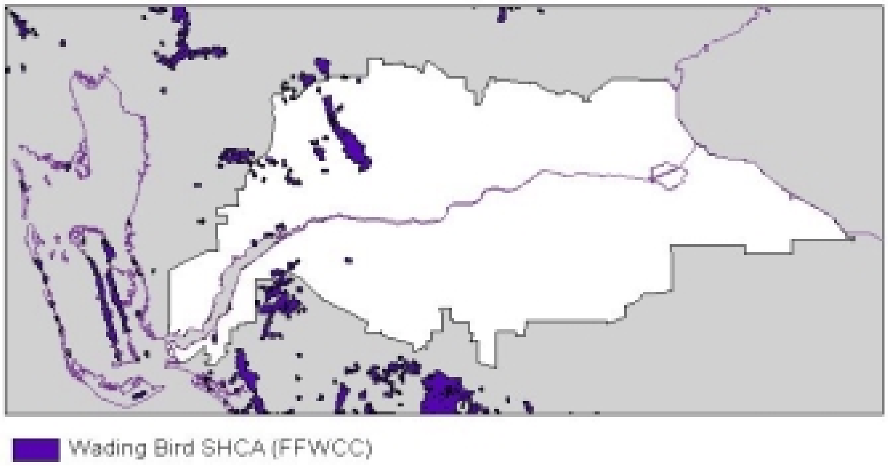


Figure 2.10 Strategic Habitat Conservation Areas for Wading Birds

Florida Scrub Jay

The Florida scrub jay is a subspecies of Scrub Jay, which is widespread in the western U.S. and Mexico. It is a blue and gray crestless jay approximately 11-12 inches in length. The Florida scrub jay's habitat is restricted to scattered, often small, isolated patches of sand pine scrub, xeric oak scrub, and scrubby flatwoods in peninsular Florida. Optimal scrub jay habitat is dominated by shrubby scrub live oaks, myrtle oaks, or scrub oaks from 3-10 feet tall covering 50-90% of the area; bare ground or sparse vegetation less than 6 inches tall covering 10-50% of the area; and scattered trees, with no more than 20% canopy cover (information from Florida Fish and Wildlife Conservation Commission (FFWCC)).

The original range of the jay is estimated at 7,000 square miles but has been reduced considerably by suburban development and conversion of scrub habitats to agricultural uses. Due to this extensive habitat loss and the elimination of the scrub jays from much of its formal range, both USFWS and FFWCC now legally protect them as a threatened species.

The USFWS has developed recommendations in the Multi-species Recovery Plan for South Florida (USFWS, 1998) for the protection of the Florida scrub jay. These include: (1) determine the distribution of Florida scrub jays and status of scrub habitat in south Florida; (2) maintain scrub jay habitat and distribution data in a GIS database; (3) protect and enhance Florida scrub jay populations; (4) develop a reserve design for Florida scrub jays in south Florida using landscape maps, GIS and spatially-explicit population models; (5) protect, manage, and enhance Florida scrub jay populations on public lands; (6) protect, manage, and enhance Florida scrub jay populations on privately-owned lands; (7) enforce available protective measures (Sections 7 and 10 ESA); (8) conduct risk assessment analysis to determine the probability of persistence of the scrub jay in south Florida, given the current amount of suitable scrub habitat, as well as potentially restorable scrub habitat; (9) study the effects of habitat fragmentation due to urbanization; (10) monitor scrub jay populations; (11) inform and involve the public; (12) prevent degradation of existing scrub habitat; (13) prioritize areas identified in reserve design for acquisition and donations; (14) protect scrub jay habitat on private lands through easements, acquisitions, and donations; (15) continue State and Federal land acquisition efforts; (16) maintain suitable habitat for scrub jays; (17) prevent loss or fragmentation of scrub habitat within scrub jay reserves; and (18) monitor scrub habitat that is occupied by scrub jays to insure public lands are managed to maintain scrub in suitable conditions for scrub jays, and to assess when unmanaged areas become unsuitable for scrub-jays.

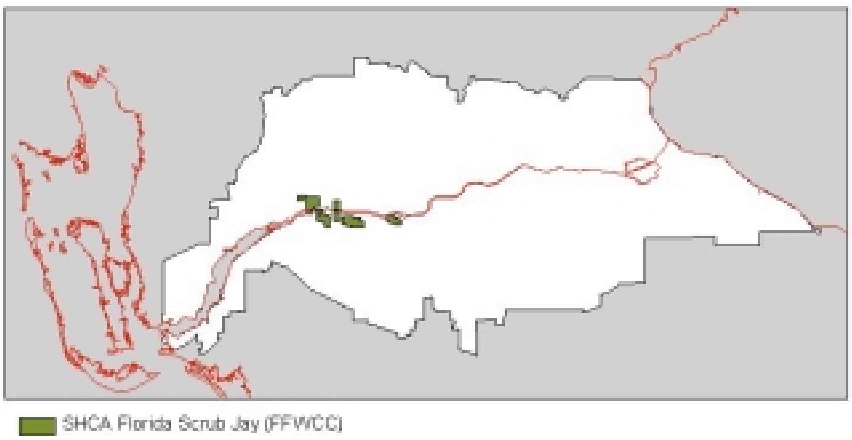


Figure 2.11 Strategic Habitat Conservation Areas for the Florida Scrub Jay

WATER NEEDS

Wetlands

Maintaining appropriate hydrology (water levels and hydroperiod) is the single most critical factor in maintaining a viable wetland ecosystem (Duever, 1988; Mitch and Gosselink, 1986; Erwin, 1991). Rainfall, along with associated groundwater and surface water inflows, is the primary source of water for the majority of wetlands in the Caloosahatchee Basin. The natural variation in annual rainfall makes it difficult to determine what the typical water level or hydroperiod should be for a specific wetland system. Because wetlands exist along a continuous gradient, changes in the hydrologic regime may result in a change of the position of plant and animal communities along the gradient. The effects of hydrologic change are both complex and subtle. They are influenced by and reflect regional processes and impacts as well as local ones (Gosselink et al., 1994).

Studies of southwest Florida wetland communities indicate that species composition and community type are largely determined by water depth and hydroperiod (Carter et al., 1973; Duever, 1984; Duever et al., 1986). Some wetlands contain water depths of 3 feet or more and are inundated year round, while other communities are characterized by saturated soils or water depths of less than a few inches that inundate the land for relatively short periods of time during the wet season. Wetland flora and fauna adapted to deep water and long periods of inundation are generally not well adapted to shallow water or a shortened hydroperiod. Complete drainage of a wetland severely alters wetland community organization and species composition. Partial drainage of wetlands can be caused by groundwater withdrawals in adjacent upland areas. These withdrawals effectively lower underlying water tables and "drain" wetlands (Rochow, 1989). Drainage facilities such as canals and retention reservoirs constructed near wetlands have a history of draining and reducing hydroperiods of south Florida wetlands (Erwin, 1991). A major concern of reduced water depths and shortened hydroperiods within wetlands is the invasion of exotic plants such as melaleuca and Brazilian pepper.

Rainfall, along with associated groundwater inflows, is the primary source of water for the majority of wetlands in the basin. Rainfall in south Florida is highly variable. Although the region has a distinct wet and dry season, the timing and amount of rainfall that falls upon a particular wetland varies widely from year to year. As a result, wetland hydroperiod also varies annually. Hydroperiod information collected from a wetland during a series of wet years may vary considerably from data collected during a dry year. This wide variation in annual rainfall makes it difficult to determine what the appropriate water level or hydroperiod should be for a specific wetland ecosystem. Determining appropriate water level or hydroperiod conditioned for a wetland often requires a data collection effort that spans a significant period of record. Hofstetter and Sonenshein (1990) suggest alterations that shorten hydroperiods may be detectable within 8 to 10 years.

Uplands

The water supply needs of upland plant communities are not well known. It is assumed that forest and herbaceous plant vegetation utilize the upper 6 to 10 feet of the surficial aquifer. Flatwoods are the dominant upland habitat within the basin. These plant associations are characterized by low, flat topography and poorly drained, acidic, sandy soils. In the past this ecosystem was characterized by open pine woodlands and supported frequent fires (Myers and Ewel, 1990). Three factors including fire frequency, soil moisture, and hydrology, play important roles in maintaining plant community structure and function and are also considered important as determinants of the direction of plant community succession. Fire, more than any other factor influences the structure and composition of upland plant communities.

Fire, under natural conditions, maintains flatwoods as a stable and essentially nonsuccessional plant association. However, when drainage improvements, construction of roads, or other fire barriers alter the natural frequency of fire, flatwoods can succeed to several other plant community types. The nature of this succession depends on soil characteristics, hydrology, available seed sources or other local conditions (Myers and Ewel, 1990). The hydrology of upland plant communities varies with elevation and topography. Seasonal variations, as well as local withdrawals from ground water, play an important role in determining the type of upland vegetation that will develop.

Wildlife

In south Florida the dominant physical factors which influences the species composition, distribution and abundance of wildlife are the annual pattern of rainfall, water level fluctuations, and fire, as well as occasional hurricanes, frosts, and freezes. Biological factors such as predation, competition and feeding habits also play important roles in configuring wildlife communities.

Alterations in water depth and/or hydroperiod that result in changes to vegetative composition densities and diversity may lead to the degradation of fish and wildlife habitat. One of the causes of melaleuca infestation is a decrease in water table levels which, when a seed source is present, can result in monotypic stands of tightly packed trees that have the potential to cause a localized decrease in biodiversity.

Wetland vegetative productivity usually exceeds that of other habitat types. Reduction in size of a wetland reduces food production at the bottom of the food chain. Alterations of the seasonal wet and dry pattern can also cause impacts. "The life cycle of many species are tied to this cycle. Wood storks, for example, are unable to successfully fledge their young without the dry season concentration of food. Anything that interferes with the cycle, too much water in the dry season or not enough in the wet season, tends to reduce fish and wildlife populations" (University of Florida, Center for Government Responsibility, 1982).

Flooding of wetlands during the summer months initiates the production of aquatic plants such as attached algae (periphyton) and macrophyte communities. Small fish and invertebrates consume these plants. Maximum numbers of fish and invertebrates occur near the end of the wet season. As marsh water levels decline during the dry season, these organisms are concentrated into smaller and smaller pools of water where they become easy prey for wading birds and other species of wildlife. Fish and invertebrates are the major dietary components of South Florida wading and water bird populations. Wading bird nesting success is highly dependent upon the natural seasonal fluctuations in hydroperiod of these marsh systems and the concentration of food resources. Kahl (1964) and SFWMD (1992) link the nesting success of wood storks and white ibis to the hydrologic status of regional wetland systems.

PROTECTION OF NATURAL RESOURCES

The SFWMD protects and enhances natural resources through its wetland policies and rules, wellfield location criteria, wetland buffers, wellfield monitoring, wetland mitigation banking, surface water planning, and land acquisition programs.

Wetland Policies

The SFWMD undertakes regulatory control measures to prevent adverse impacts to wetlands from ground water withdrawals by incorporating numerous state laws into its consumptive use permitting process, which limit drawdowns beneath wetlands. The obligation to leave enough water in natural areas to maintain their functions and protect fish and wildlife is central to water supply planning.

The State Comprehensive Plan (Chapter 187, Florida Statutes) states as a goal that Florida “shall maintain the functions of natural systems and the overall present level of surface and ground water quality.” The same document lists as a policy: “reserve from use that water necessary to support essential non-withdrawal demands, including navigation, recreation, and the protection of fish and wildlife.” The Water Resources Act of 1972 (Chapter 373, Florida Statutes) states: “The minimum water level shall be the level of ground water in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area." The SFWMD's Water Supply Policy Document affirms that "the SFWMD recognizes the state policies which establish priority protection of the water supply required to maintain and enhance healthy natural systems."

The extent to which wetland preservation conflicts with water supply development depends greatly on the approach of that development. For example, options that increase water storage relieve the conflict between wetlands and human development, as does appropriate location and design of wellfields or the use of surface water. The challenge is to accept wetland protection as a constraint and then come up with the most reliable and cost-effective water supply strategy. The water needs of wetlands must be met. The plan's approach at this time is to meet the intent of specific flows and levels for isolated inland wetlands, and to protect them against changes in existing water regimes.

Wetland Protection Criterion

In order to assess the potential harmful impacts of cumulative water use on the environment and ground water resources using the ground water modeling tools, the potential impacts must be defined in terms of water levels and duration and frequency of drawdowns. These water levels are referred to as resource protection criteria. The resource protection criteria are guidelines used to identify areas where there is potential for cumulative water use withdrawals to cause harm to wetlands and ground water resources. Areas where simulations show the resource protection criteria are exceeded during the selected level of certainty are areas where the water resource may not be sufficient to support the projected demand under the constraints.

Resource protection criteria in this plan are designed to prevent harm to the resources up to a 1-in-10-drought event. These criteria are not intended to be a minimum flow and level. For drought conditions greater than a 1-in-10 event, it may be necessary to decrease water withdrawals to avoid causing significant harm to the resource. Water shortage triggers, or water levels at which phased restrictions will be declared under the SFWMD's water shortage program, can be used to curtail withdrawals by water use types to avoid water levels declining to and below a level where significant harm to the resource could potentially occur.

The wetland protection criterion is defined as follows: Ground water level drawdowns induced by cumulative pumping withdrawals in areas that are classified as a wetland should not exceed 1 foot at the edge of the wetland for more than 1 month during a 12-month drought condition that occurs as frequently as once every 10 years. For planning purposes, this criterion was applied to surficial aquifer drawdowns in areas that have been classified as a wetland according to the National Wetlands Inventory. For the purpose of this plan, the existing one-foot wetland drawdown criteria will be used.

Section 3.3, Environmental Impacts, of the SFWMD's Basis of Review for Water Use Permit Applications (BOR-1997), requires that withdrawals of water must not cause adverse impacts to environmental features sensitive to magnitude, seasonal timing and duration of inundation. Maintaining appropriate wetland hydrology (water levels and hydroperiod) is scientifically accepted as the single most critical factor in maintaining a viable wetland ecosystem (Duever, 1988; Mitch and Gosselink, 1986; Erwin, 1991). Water use induced drawdowns under wetlands potentially affect water levels, hydroperiod, and the arial extent of the wetland. A guideline of no greater than one foot of drawdown at the edge of a wetland after 90 days of no recharge and maximum day withdrawals is used currently for consumptive use permitting (CUP) purposes to indicate no adverse impacts. Wetlands for CUP purposes are delineated using the statewide methodology as described in Chapter 62-340, F.A.C.

The wetland protection criteria used in this plan are intended to be consistent with the guidelines currently used in the CUP program. Modeling studies conducted in conjunction with the SFWMD's Lower West Coast Water Supply Plan and the CWMP Water Supply Plan suggested that the withdrawals associated with different use types might have different drawdown impacts at wetlands. It was concluded that for public water supplies, the 90-day no recharge guideline currently used was equivalent to five months of maximum day pumpage in models with 1-in-10 year drought conditions and recharge.

Wellfield Location

Locating wellfields away from wetlands is an approach that can reduce local environmental effects but is not always easy to implement. Often the choice is reduced to either locating the wellfield in undeveloped areas with environmentally sensitive wetlands or in developed uplands where the potential for wellfield contamination is a serious concern.

Wetland Buffers

Another approach involves using man-made lakes or reservoirs as a buffer between wellfields and natural wetland systems. The water in these lakes act as a buffer by managing the local water table at a sufficient level to avoid impacts to nearby wetlands. The surface water that is available in these reservoirs can also be used to supplement groundwater withdrawals.

Wellfield Impact Monitoring

The SFWMD's Resource Assessment Division began a research program in 1995 to support development of wetland drawdown criteria. This project involves long-term monitoring of wellfields and wetland systems, including some systems in the CWMP planning area. The research project is broken down into three phases.

Phase I consists of: (1) a literature review to determine if sufficient information is present to support existing drawdown criteria or to recommend new criteria; (2) groundwater modeling; and (3) a scientific wetland expert workshop. This phase was completed November 1995.

The objectives of Phase II were to: (1) determine the extent and severity of impacts, if any, caused by ground water withdrawals under present and past drawdown criteria; and (2) identify wetland sites throughout the SFWMD for well installation and hydrobiological monitoring. The completion date for Phase II was December 1996.

Phase III has two main objectives: (1) implement long-term hydrobiological monitoring at wetlands located along a gradient of drawdown in selected study sites; and (2) test hypotheses regarding: (a) the effects of groundwater drawdowns on wet season biological productivity; (b) the dependence of surface soil moisture on the dry season water table position; (c) differences in ecosystem structure and function between wetlands subject to different amounts of drawdown; (d) the effects of local versus regional calibration of groundwater models used in the permit application process; and (e) symptoms of impact observed during drought.

Presently, two years of data have been collected and analyzed. This information is in draft form in Hydrology of Isolated Wetlands of South Florida: Results of 1997-1998 Monitoring and Data Analysis and Guidance for Developing Wetland Drawdown Criteria (Shaw and Huffman, 1999). Biological studies will facilitate the characterization of biotic communities of the selected wetland sites and development of non-destructive long-term monitoring methods. To date, inventories of plant, fish, aquatic insect, bird, moss, algae, and amphibian populations have been conducted. Various sampling methods are presently under investigation for incorporation into a long-term monitoring effort.

Monitoring wetlands adjacent to wellfields ensures that withdrawal impacts are detected. Steps can then be taken to limit further impacts. Long-term monitoring of wetlands adjacent to wells provides documentation of impacts to wetlands that occur over time.

The hydrologic and biologic consequences of ground water withdrawal from wellfields in the Northern Tampa Bay region have been documented by the Southwest Florida Water Management District (SWFWMD). After long-term monitoring of wells and wetland systems, SWFWMD concluded that adverse impacts are especially evident in areas where ground water modeling of withdrawals indicates a drawdown of one foot or more.

The type of impacts noted for marsh and cypress wetlands were:

- extensive invasion of weedy upland species
- destructive fires
- abnormally high treefall
- excessive soil subsidence/fissuring
- disappearance of wetland wildlife

The SWFWMD ground water modeling has also shown that it may take one to two decades for the full effect of wellfield pumpage to be realized. Therefore, actual water levels in newer wellfields, or in wellfields currently not pumping at their maximum permitted levels, could become lower in the future. For these and other reasons, SWFWMD suggests that continued environmental monitoring will be necessary to ensure that Florida's wetlands are adequately protected (Rochow, 1984).

Wetland Mitigation Banking

Wetland mitigation banking is a relatively new natural resource management concept, which provides for the advanced compensation of unavoidable wetland losses due to development. The Florida Environmental Reorganization Act of 1993 directed the water management districtSFWMDs (WMDs) and the Florida Department of Environmental Protection (FDEP) to participate in and encourage the establishment of public and private regional mitigation areas and mitigation banks. The act further directed the WMDs and FDEP to adopt rules by 1994, which led to the state's mitigation banking rule (Chapter 62-342, F.A.C.), becoming effective January 1994. In 1996, House Bill 2241 further developed this program by providing for the acceptance of monetary donation as mitigation in SFWMD and FDEP endorsed offsite regional mitigation areas. The bill clarified service area requirement credit criteria and release schedules, assurances, and provisions that apply equally to public and private banks. As a result, the SFWMD and FDEP will adopt rules to implement these provisions. Wetland mitigation banking does not apply to water use related impacts.

Surface Water Improvement and Management

Under the provisions of the Surface Water Improvement and Management (SWIM) Act, the SFWMD was required to develop and implement a SWIM plan to preserve, protect, and restore Lake Okeechobee. The Lake Okeechobee SWIM Plan was enacted in 1989 and had its second update in August 1997. The environmental element recognized that adverse impacts to the Caloosahatchee Estuary occur when regulatory releases are made through C-43 Canal for lake flood protection purposes. Large, unnatural freshwater releases from the lake through the C-43 to the Caloosahatchee Estuary alter the estuarine salinity gradient and transport significant quantities of sediment to the estuary. Biota within the Caloosahatchee Estuary, and near-shore seagrass beds can be negatively affected by these high volume discharges.

Minimum Flows and Levels

The purpose of establishing minimum flows and levels (MFLs) is to avoid diversions of water that would cause significant harm to the water resources or ecology of an area. The Florida Legislature has mandated that all water management districts establish MFLs for surface waters and aquifers within their jurisdiction. Section 373.042(1) defines the minimum flow as “the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.” It further defines the minimum level as the “level of ground water in an aquifer and the level of surface water at which further withdrawals would be harmful to the water resources of the area.” The SFWMD is further directed to use the best available information in establishing a minimum flow or a minimum level.

The overall purpose of Chapter 373 is to ensure the sustainability of water resources of the state (Section 373.016, F.S.) To carry out this responsibility, Chapter 373 provides the SFWMD with several tools, with varying levels of resource protection standards. MFLs play one part in this framework. Determination of the role of MFLs and the protection that they offer, versus other water resource tools available to the SFWMD, are discussed below.

The scope and context of MFLs protection rests with the definition of significant harm. The following discussion provides some context to the MFLs statute, including the significant harm standard, in relation to other water resource protection statutes.

Sustainability is the umbrella of water resource protection standards (Section 373.016, F.S.). Each water resource protection standard must fit into a statutory niche to achieve this overall goal. Pursuant to Parts II and IV of Chapter 373, surface water management and consumptive use permitting regulatory programs must prevent **harm** to the water resource. Whereas water shortage statutes dictate that permitted water supplies must be restricted from use to prevent **serious harm** to the water resources. Other protection tools include reservation of water for fish and wildlife, or health and safety (Section 373.223(3)), and aquifer zoning to prevent undesirable uses of the ground water (Section 373.036). By contrast, MFLs are set at the point at which **significant harm** to the water resources, or ecology, would occur. The levels of harm cited above, harm, significant harm, and serious harm, are relative resource protection terms, each playing a role in the ultimate goal of achieving a sustainable water resource.

Where does the significant harm standard lie in comparison to the consumptive use permitting and water shortage standards? The plain language of the standards of harm versus significant harm, although undefined by statute, implies that the minimum flow or level criteria should consider impacts that are more severe than those addressed by the consumptive use permitting harm standard, but less severe than the impacts addressed by the serious harm water shortage standard. The conceptual relationship among the terms harm, significant harm, and serious harm are shown in Figure 2.12. MFLs for the Caloosahatchee Estuary will be established no later than December 2000 and incorporated into the Lower West Coast Water Supply Plan.

Section 373.0421 requires that once the MFL technical criteria have been established, the water management districts develop a prevention or recovery strategy for those water bodies that are expected to exceed the proposed criteria. It is possible that the proposed MFL criteria cannot be achieved immediately because of the lack of adequate regional storage. Pending congressional authorization of theRestudy, these storage shortfalls may be resolved through construction of facilities that will increase the region's storage capacity. Operational strategies, including supplementing flow to the C-43 canal during the dry season with water from Lake Okeechobee, will be evaluated.

The SFWMD's effort in managing flows to the Caloosahatchee Estuary has focused on ecological criteria. Oysters and submerged aquatic vegetation (SAV) have been selected as key indicators of healthy estuarine systems because they provide food and/or habitat for much of the estuarine community. Accordingly, the SFWMD is evaluating ways to establish healthy, self-perpetuating populations of these organisms in the Caloosahatchee Estuary. Hydrodynamic salinity models have been developed which can predict salinity regimes in estuaries based on freshwater inflows. Geographic Information System coverages (including substrate type, shoreline features, and current SAV and oyster distributions) are being developed for the estuary. Comparing these coverages with salinity model output will help refine where oysters and SAV could occur once flow management strategies are in place. Optimization models are being used to help predict how much water must be held back in the watershed, as well as to determine schedules for releasing the stored water to meet the salinity requirements of oysters and SAV. Ultimately this information will be coupled with watershed models to evaluate specific "in watershed" management scenarios needed to meet the inflows necessary to maintain healthy SAV and oyster community requirements.

The U.S. Army Corp of Engineers in cooperation with the SFWMD has evaluated environmental and economic impacts associated with proposed regulation schedules for Lake Okeechobee. The regulation schedule dictates the water levels within the lake and regulatory discharge strategies to maintain these levels. This study was completed in 1999.

Two water bodies within the LWC Planning Area are on the SFWMD’s priority list for establishment of MFLs: the Caloosahatchee Estuary and the LWC aquifer system. Both of these are anticipated to be completed by the end of 2000. Additional information on these is provided in the Planning Document.

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